of the Yarra again between the Heads, similar to the mouth of the Murray in South Australia. "That river now flows through a lake (Victoria Lake) which, during the greatest portion of the year, is the receptacle of the fresh waters of the Murray itself. Before the land rose the river flowed through waters as permanently and exclusively salt as those of Hobson's Bay at this day."

Whether this epoch is near or far we can form no idea. Multiplied observations will be necessary before we are able to tell how many inches or feet the land has risen in so many years or centuries.

I have heard from the Surveyor-General of Victoria that six tide gauges are about to be erected in suitable places. By means of these we shall be able to ascertain how much the land is rising in a given time. But it is to be wished that all the Australian Colonies should erect similar tide gauges; and the observations thereon, in connection with the notes, made during and after an earthquake, ought to be mutually exchanged, after certain intervals of time. It is most important, both for science and practical life, to know on what ground each of them is standing.

Melbourne, Oct. 22, 1855.

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## Art. IV.—*On a Proposed Floating Railway Pier.* By Frederick Acheson, Esq., C. E.

*(Abridged.)*

In a great city like Melbourne, an object of primary importance must always be a ready communication with the vessels of all draught lying in its port, so that facility of discharge and loading may be obtained without the inconvenience and loss arising from frequent transhipment. To attain this end, various schemes have been proposed, embracing the construction of a ship canal and docks; deepening the river Yarra, so as to render it navigable for vessels of deep draught up to the Queen's Wharf; and, finally, the construction of piers from the Hobson's Bay and Williamstown Railways into deep water in Hobson's Bay. The merits of these various schemes have been often discussed, and it will therefore not be necessary to enter upon them here. I will simply state my own conviction, that were it practicable to construct a pier from either of the railways into deep water, so as to give sufficient frontage to vessels loading and unloading, such would answer all required purposes, and render the construction of the ship canal and docks unnecessary, for I do not see much advantage gained by having goods discharged at once on the Melbourne wharves, instead of into a railway truck in Hobson's Bay, although further off; which latter plan has a decided advantage as regards the landing of merchandise destined for the interior, supposing the railway system complete. It, however, unfortunately happens that the practicability of efficiently constructing such piers in the Bay, is rendered extremely doubtful, owing to the assertion that the shifting character of its bed will not hold firmly the driven piles. The original design of running out a pier from Hobson's Bay Railway, has, therefore, been arrested in its execution before reaching the length necessary to render it accessible to vessels of large draught.

The Hobson's Bay Railway thus shorn of its fair proportions, necessarily fails to accomplish the great end for which it was designed, and never can be looked upon as a great benefit to the commercial interests of Melbourne, until its extension into the deep water has rendered it accessible to vessels of all draught, and ample frontage has been afforded.

Convinced as I have been for some time past that a railway pier, presenting great frontage to the deep water of the Bay, is the most legitimate plan for communication between the city and the shipping, and also best adapted for the discharging and loading of cargoes, I have given some consideration to the subject, with the view to ascertaining if such a scheme be practicable by other means than the pile system —I allude to the possibility of constructing a floating pier of such stability as to permit of the easy and safe passage of railway waggon-trains over it, and which shall be of a durable material and sound construction.

It is a simple matter to ascertain the effect produced upon any floating body by superincumbent weights: the depression consequent thereon can be exactly calculated; and were the depression in the water the only difficulty to be overcome in rendering floating lines applicable to railway transit, I would not doubt of success for a moment; but there are two other forces in operation, having a disturbing effect, namely, the rise and fall of the tide constantly changing the level, and therefore breaking with the permanent level of the rails on land; and also the frequently perturbed state of the adjacent waters, which communicate an oscillatory motion to all bodies floating on them. A pier thus at the mercy of the waves and the tides would be manifestly unsuited to the purposes required, were its dimensions confined to reasonable limits. With obstacles like these last to be overcome, I consider the successful adaptation of floating piers in the ordinary form, and as hitherto known to railway purposes, exceedingly problematical.

Feeling, as I have long done, the great importance of the subject, I directed my attention some time back to the contrivance of some means of rendering floating bodies insensible to exterior forces, acting either laterally with a rolling motion, or vertically, and thus to attain a rigidity of position, as if on land, but of course within certain limits.

The depression in the water caused by placing a given weight upon a floating body, led me to the idea that a uniform level of immersion might be completely attained by previously forcing and holding down the floating body so much below its natural floatation level as it would sink if the above weight had been placed upon it. It then being tied down or confined to a forced level, it would have a tendency to ascend to its own floatation level, but cannot on account of being held down: it has, in fact, an upward pressure equal to the force employed in depressing it. It is manifest that the floating body in this state, would resist all attempts to depress it by means of superincumbent weights, until those weights exceeded its upward pressure. To make my meaning clearer, I will suppose that it is required to render a floating body insensible to a weight of ten tons to be placed upon it, or that such weight when placed shall not depress it in the water. To effect this, the floating body must be depressed in the first instance by loading it with ten tons, and at this level in the water it should be chained down to the bottom: the depressing agent, or ten tons, being then removed, the floating body has a tendency to ascend or upward pressure of ten tons, but nevertheless retains its depressed level, being tied down. Under these conditions, therefore, it will bear all weights placed upon it not exceeding ten tons, and resist depression therefrom by virtue of its neutralising upward pressure of ten tons.

The application of this principle to obtaining a uniform water line, irrespective of variation of weight of the floating body in non-tidal and quick waters, must be obvious.

In order to illustrate the adaptation of the above principle to practical purposes, I have prepared a design for a floating railway pier in accordance therewith, and such as would be suitable for the extension of the Hobson's Bay Railway into deep water.

To successfully apply any scientific principle to practical results, it is not only necessary that such be theoretically consistent with the object, but also that suitable materials are attainable, and such a structural character be adopted as the peculiarity of the case may demand.

I accordingly felt the necessity of employing such a material, which, combined with form and constructive arrangement, as would realize my original principle, and also entail enormous strength and durability.

After mature consideration I concluded that a wrought-iron tube of suitable width and depth, formed of boiler-plate, and having a cellular arrangement on its sides and surface, and the whole rivetted in the same fashion as the Britannia Tubular Bridge, would answer all required conditions.

The construction of such a pier is shown in the design accompanying, as also the mode of rendering it insensible, as regards position and steadiness to external forces, arising from violence of the waves, tidal changes, or the passage of railway waggons over its surface. I propose that the tubes shall be constructed in lengths of 100 feet each, closed at the ends, and capable, when placed in position one after the other, of being bolted or rivetted together so strongly as to form, when thus united, one hollow beam of uniform strength.

It should be borne in mind that the plan of pier here described is designed strictly as a means of communication with the shipping, and not as a wharf or landing-place, so that the goods may be discharged over the ship's sides directly into the railway waggons, and drawn off without ever touching the pier itself. This arrangement admits of great economy of material in the construction, for the width of the pier is thereby limited to the dimensions sufficient for a double line of rails, or 25 feet, space being allowed in the middle for persons passing.

As the design in question specially relates to Hobson's Bay, my calculations shall be in reference to its fitness for same, and shall bear upon one length or compartment of 100 feet.

The weight of the tube is nearly a ton per foot forward: therefore 100 feet, or one compartment, would weigh 100 tons, which then would displace 100 tons of water, or 3530 cubic feet when floating therein. The superficial content of same is 2400 square feet, which, divided into the amount displaced, will give the depth of displacement at 1.5 feet nearly, which therefore represents the natural line of draught of the tube. It is evident that all waggons or trains coming upon the tube subsequent to this, will depress it further, until they have displaced their own weight of water, this being the very result that it is my aim to avoid.

I have estimated the greatest weight that can be placed upon the pier at nearly 94 lbs. per square foot, or 1 ton per foot forward, or for each compartment of 100 feet 100 tons, which thus doubles the weight of the pier, and will of course double the amount of draught, and make it three feet.

As I have before explained, the floating body, or pier, is rendered insensible to depressing agency by forcing it down, in the first instance, so much below its own line of draught, and confining it to that level as to displace such a weight of water as will be equal to the weight it is required to bear. Each compartment, therefore, in this instance is depressed 1.5 feet below its own line of draught, and then held to that level by strong chain cables attached to submarine moorings directly underneath. The load of 100 tons, by means of which it was depressed to this level, being then removed, it will have an upward pressure, without motion, of 100 tons. It is thus in a position to permit of the passage of rolling waggon-trains not exceeding 100 tons weight, over its surface; and therefore no depression in the water, or further displacement, can ensue as long as the upward pressure exists to prevent it.

The above calculation of the sustaining power or upward pressure of 100 tons, has been made with reference only to a uniform level of the water, and truly represents the different relations of weight and upward pressure affecting the tube, as, according to my design, would exist at low water in Hobson's Bay.

But as the tide rises three feet, while the level of the tube is permanent, and as 1.3 feet in depth of displacement gives 100 tons of upward pressure, the increase in the height of the tide of three feet being double the depth, and consequently gives double this displacement, an addition of 200 tons will thereby be added to the former upward pressure, making in all 300 tons at high water. The mean upward pressure upon the tube, therefore, between high and low water, will be 200 tons, which is opposed to counteract the estimated downward pressure or gravity of 100 tons from the waggon transit on the surface.

If I have established by the above figures that it is possible to render a floating pier unaffected as to level by the passage of loaded trains over it, it may yet be objected that a perturbed state of the adjacent water may communicate a rolling motion to it; but a little attention to the subject will lead to a different conclusion.

When a body rolls in the water, it is necessary that one side should be elevated out of the water as much as the opposite is depressed therein. Hence, should rolling occur in this case, the side depressed should be acted upon by a rolling force sufficient to overcome its least upward pressure of 100 tons; and the side upheaved should be acted upon by a force sufficient to snap it from its moorings below, which should exceed 300 tons, as the chain cables and submarine moorings at the bottom must be at least strong enough to counteract that upward pressure, so as to prevent the tube from rising to its own draught line. From this it is clear that a perturbation of the water must overcome the strength of the materials before affecting the steadiness of position of the pier.

There is yet an important point to be considered. I have shown that each compartment of the tube is subjected to an upward pressure of 300 tons at high water; and as it is tied down to submarine moorings by means of chain cables, in order to preserve it at a permanent level, it is clear that not only the chain cables must be proof against this strain, but that the nature of the moorings must be such as to afford a perfect holdfast. I therefore think it advisable that in order to sustain an actual weight of 300 tons, they should be proof against 500 tons at least. The submarine moorings consist of large troughs made of boiler-plate, properly ribbed, 25 feet long, 17 feet wide, and 10 feet deep, placed immediately under the tube at intervals of 100 feet, or one for each compartment. They are filled with stones, gravel, or sand, and are connected with the tube above by strong chain cables, as shown in the plan: the strength of mooring thus obtained being represented by the weight of the whole in water, and being only 120 tons, is hence insufficient of itself; but when these troughs are connected with the bottom with screw piling, it is manifest that any amount of strength required will be obtained.

It may be thought that a floating pier carried out like this, and terminating without any rigid connection with the bottom of the Bay, as if on an abutment, will not be sufficiently protected, and be subject to lateral displacement by pressure from the sides of ships: with regard to which I would observe, that, irrespective of the means already provided in my plan by means of submarine moorings, producing upward pressure and consequent steadiness, the immense momentum of such a floating mass, being 1500 feet long, and weighing 1500 tons, alone would protect it from being affected by minor forces. There would be no difficulty, however, in terminating the pier upon an abutment formed of boiler-plate chambers, filled with concrete or gravel, and being thus secured at both extremities, and inflexible laterally, would be perfectly rigid to all exterior forces save those sufficient to snap it from its moorings.

The above observations are intended to suggest the possibility of obtaining an unyielding principle in floating bodies which is so desirable in many instances, such as the crossing of estuaries, where it is impossible to erect rigid structures, owing to depth or badness of bottom; and although the subject is imperfectly considered in this paper, it is hoped that the principle started therein may yet be brought to bear practically, when necessity shall insist upon a departure from plans unsuited to extraordinary circumstances.

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## Art. V.—*Report II. of* William Blandowski, Esq. *to the Honourable the Surveyor-General, on an Excursion to Frankston, Balcomb's Creek, Mount Martha, Port Phillip Heads, and Cape Shank.*

Camp at Western Port, 31st December, 1854.

On the 20th November, 1854, I started on an excursion round the Southern coast, towards Cape Paterson; on my route I visited the mouth of the Mordialloc Creek, Frankston, Balcomb's Creek, Mount Martha, and Arthur's Seat, the Heads, Cape Shank, and Western Port.

I. The road runs nearly parallel with the coast, but between Melbourne and Frankston offers nothing worthy of particular observation.

The land is elevated about ten or twenty feet above the level of the sea, and in general is flat and sandy. Groups of very fine honeysuckle trees of an uncommonly large size are abundant near the shore, offering a shady retreat to the great funereal cockatoo (372, *Calyphlorhynchus funereus*) and patches of dense tea-tree scrub also impart a peculiar character to the coast.

The ford at the Mordialloc is difficult and dangerous to